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ABSTRACT

A chronology of the development of a mathematics anxiety scale is given. Included are a model describing six facets of mathematics anxiety and the eighteen items used on the anxiety scale. Stability and internal consistency measures are reported, and the scale is correlated with measures of mathematical confidence and general anxiety towards school. (Author/MK)

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DEVELOPMENT OF THE SYRACUSE MATHEMATICS ANXIETY SCALE

by

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Sheila Tobias (1978) and others have called attention to the negative effects of mathematics anxiety. Persons having feelings of aversion or anxiety towards mathematics frequently limit their educational and career choices by avoiding situations in which they would be expected to study or use mathematics. The availability of a reliable and valid instrument for measuring mathematics anxiety is essential both for the facilitation of further research in this area and for the detection of individuals with debilitating levels of mathematics anxiety. This paper describes the development of an instrument for use in detecting mathematics anxiety in freshmen at Syracuse University.

Two scales purportedly measuring mathematics anxiety were found to exist. These include the Mathematics Anxiety Rating Scale developed by Richardson and Suinn (1972) and the Math Anxiety Scale developed by Fennema and Sherman (1976). However, research conducted by Rounds and Hendel (1979) indicates that both of these scales are predominantly measures of test anxiety rather than anxiety towards mathematics.

The first step in the development of the Syracuse scales was to define an appropriate content domain from which items could be sampled. The various facets of the construct were defined in terms of the 3 x 2 matrix shown in Figure 1.

Insert Figure 1 about here

The rows represented three different ways in which mathematics anxiety are likely to be manifested: (1) verbalized feelings of distress, (2) avoidance

of situations involving mathematics, and (3) impaired mathematical performance. The two columns of the matrix represented situations in which math anxiety could occur: (1) formal learning situations involving mathematics, and (2) practical situations in everyday life requiring the use or application of mathematics.

Forty-one Likert-type statements representing the six cells of the matrix were generated and organized into two scales: (1) a Math Learning (ML) scale consisting of 19 items intended to measure anxiety towards formal learning situations involving the study of mathematics, and (2) a 22-item Math Usage (MU) scale intended to assess anxiety towards the usage of mathematics in common, everyday kinds of situations. These two original scales were administered to 52 high school juniors and seniors. The students were asked to indicate the degree to which they agreed or disagreed with each statement on a four-point scale ranging from Strongly Agree to Strongly Disagree.

Responses obtained from this initial pilot-test of the scales were item analyzed. Two findings led to a decision to collapse the ML and MU scales into one combined measure of anxiety towards studying or using mathematics: (1) scores on the two scales were found to have a correlation of .80 and (2) most of the items on each scale were found to have a fairly high correlation with the total score on the <u>other</u> scale. Each of the 41 items on the combined scale was then correlated with the composite score adjusted to exclude the item itself. Twenty-three of the forty-one items were eliminated as a result.

The remaining eighteen items constitute the Syracuse Mathematics Anxiety Scale (SMAS). These items are shown in Table 1. Items 8 and 12 are positively-keyed, while all of the others are negative. The negative items

are scored using the formula strongly agree = 3, agree = 2, disagree = 1, and strongly disagree = 0. The reverse of this scoring formula is used for the two positive items. Consequently, scores on the eighteen-item scale range from zero to fifty-four with high scores indicating high levels of anxiety towards mathematics.

Insert Table 1 about here

The stability (test-retest reliability) of measures obtained from SMAS was investigated by administering the scale twice to a group of 73 incoming freshmen at Syracuse University with an intervening time period of six weeks. Results obtained from the two administrations of the scale were found to have a correlation of .84 . The internal consistency (Cronbach's Alpha) was .95 .

A 10-item Likert scale measuring general anxiety towards school or formal learning situations and a 19-item measure of confidence in mathematics problem-solving were also administered to the 73 freshmen. The confidence scale was modeled after a similar scale developed by Dowling (1978). It consisted of a mixture of arithmetic, algebra, and geometry problems. The students were not asked to solve the problems, but for each item they were asked to indicate how confident they were in their ability to solve it correctly. They responded on a five-point scale ranging from "no confidence at all" to "complete confidence." The correlation between students' scores on the math confidence and math anxiety scales was -.62 . The correlation between school anxiety and mathematics anxiety was found to be .37 . The low correlation between the

math anxiety and generalized anxiety towards formal learning situations combined with the stronger, but negative correlation between math anxiety and the math confidence scores provides support for the construct validity of the math anxiety scale. Further investigation of the construct validity of the scale needs to involve a determination of the extent to which SMAS scores are correlated with scores obtained from an appropriate measure of test anxiety. Plans for studying this issue are currently underway.

In the summer of 1979 SMAS was administered to 917 incoming freshmen. Their scores ranged from 0 to 53 with a mean of 17.6 and a standard deviation of 10.8 . The distribution was platykurtic and positively skewed, hence the scale discriminated best among students having high anxiety scores. Approximately one-sixth (15.4%) of the 917 freshmen had scores which exceeded one standard deviation above the mean. Thirty-five (3.8%) had scores exceeding two standard deviations above the mean. The means for the males ($n = 475$) and females ($n = 421$) were 16.0 and 20.1 respectively. The difference between the two means is statistically significant ($p < .001$).

The responses of the 917 freshmen to the SMAS items were also factor analyzed using principal components analysis. Results showed one factor with an eigenvalue greater than 1.0 . This factor accounted for 94% of the variance. Hence, the authors concluded that SMAS was unidimensional.

A measure of foreign language anxiety developed by the authors was also administered to the 917 freshmen. Scores on SMAS correlated .03 with the foreign language aversion scores. Responses to the 18 SMAS items and the 10 FL items were pooled and factor analyzed using principal components analysis followed by an orthogonal rotation. Two clearly-defined, uncorrelated factors emerged. The first factor accounted for 61% of the variance.

All 18 of the SMAS items had loadings exceeding .59 on this factor. All 10 of the FL items loaded on the second factor which accounted for 34% of the variance. Factor loadings for these factors are shown graphically in Figure 2.

Insert Figure 2 about here

The consistent clustering of the mathematics items on the first factor and the foreign language items on the other factor provides evidence that each scale is measuring something specific rather than aversion to school subjects in general. This clear differentiation between the items on the two scales also helps to rule out the plausibility of the hypothesis that response sets were governing the students' responses to the various items.

In summary, it appears that results obtained from SMAS are reliable. At least, they are consistent across items and stable over a six-week time period. The findings of the validity investigations are encouraging but further work remains to be done, particularly in determining whether SMAS differentiates between mathematics anxiety and test anxiety.

Figure 1

FACETS OF MATHEMATICS ANXIETY

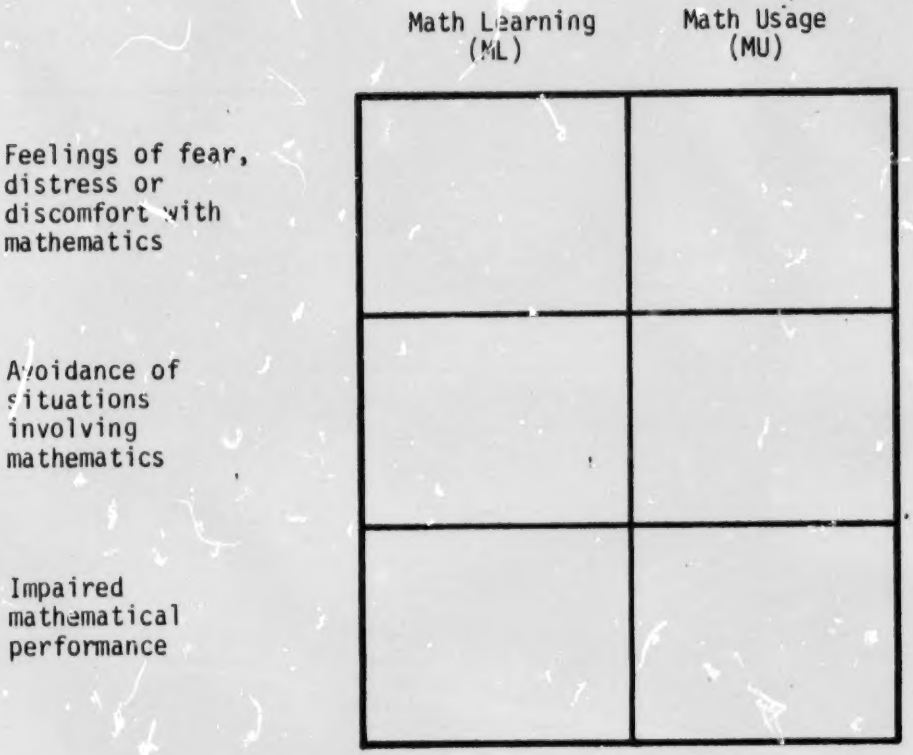
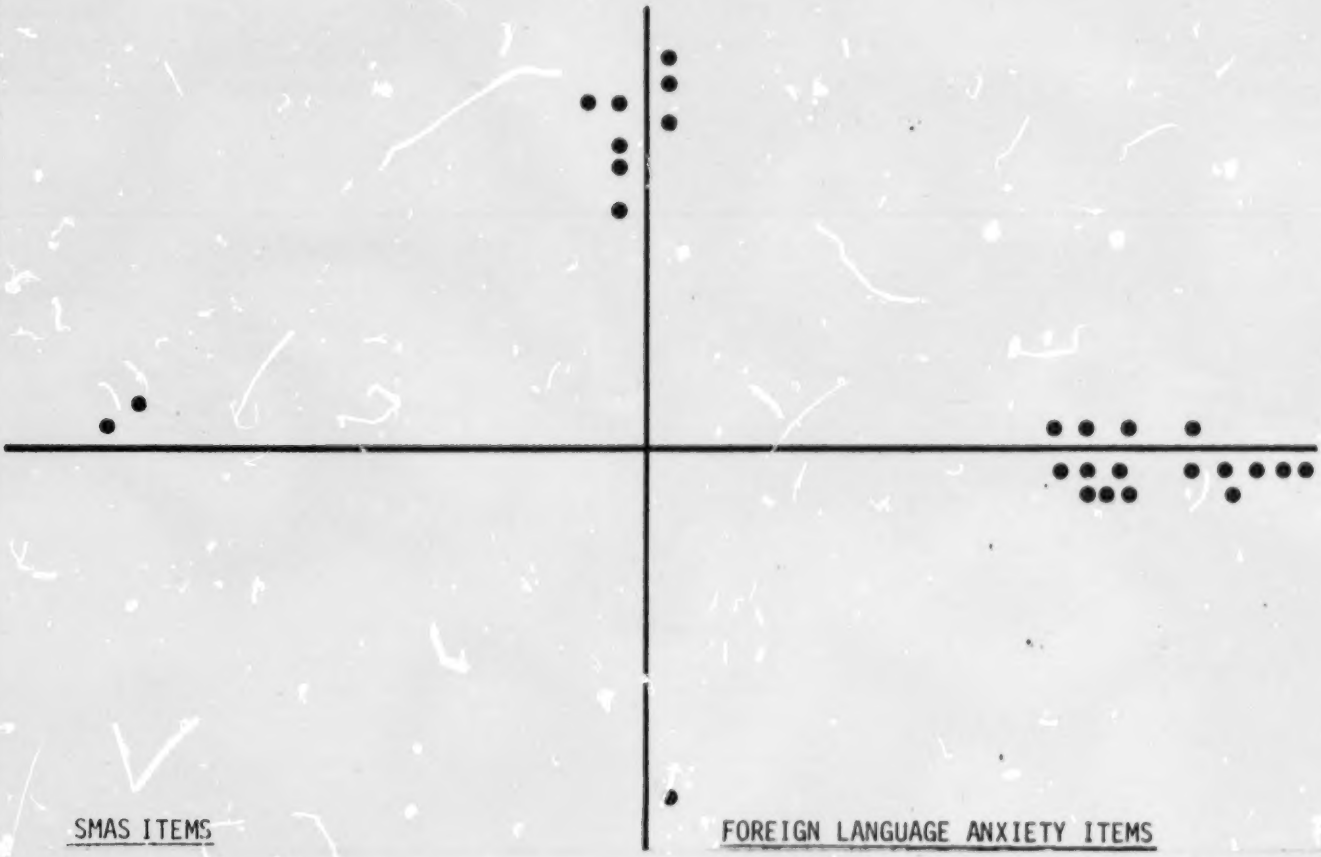

Math Learning (ML)
Math Usage (MU)
Feelings of fear, distress or discomfort with mathematics
Avoidance of situations involving mathematics
Impaired mathematical performance

Figure 2

FACTOR LOADINGS OF THE MATHEMATICS AND FOREIGN LANGUAGE ANXIETY ITEMS

HORIZONTAL FACTOR
(61% of variance)

VERTICAL FACTOR
(34% of variance)



SMAS ITEMS

	Horizontal Factor	Vertical Factor
ITEM 1	0.82	-0.01
ITEM 2	0.62	-0.02
ITEM 3	0.84	-0.01
ITEM 4	0.80	-0.07
ITEM 5	0.64	-0.03
ITEM 6	0.65	0.04
ITEM 7	0.77	0.03
ITEM 8	-0.71	0.09
ITEM 9	0.90	-0.04
ITEM 10	0.66	-0.04
ITEM 11	0.75	-0.03
ITEM 12	-0.76	0.04
ITEM 13	0.65	0.02
ITEM 14	0.60	0.05
ITEM 15	0.64	-0.01
ITEM 16	0.60	-0.01
ITEM 17	0.68	-0.07
ITEM 18	0.81	-0.04

FOREIGN LANGUAGE ANXIETY ITEMS

	Horizontal Factor	Vertical Factor
ITEM 1	-0.08	0.77
ITEM 2	-0.04	0.54
ITEM 3	0.02	-0.80
ITEM 4	-0.02	0.60
ITEM 5	-0.05	0.70
ITEM 6	-0.01	0.76
ITEM 7	0.03	0.72
ITEM 8	-0.01	0.75
ITEM 9	0.00	0.84
ITEM 10	0.01	0.83

Table 1

ITEMS ON THE SYRACUSE MATHEMATICS ANXIETY SCALE

1. I'm allergic to math courses.
2. I don't trust the answers I get when I try to solve problems that require math.
3. Studying mathematics is a painful experience for me.
4. I'm just not mathematically inclined.
5. My mind goes blank and I have trouble thinking clearly when I get in situations where I'm supposed to use mathematics.
6. I prefer to depend on someone else to solve problems for me when mathematics is involved.
7. I usually feel nervous and uneasy in mathematics classes.
8. Math is usually an easy subject for me.
9. Mathematics is one subject that I dread.
10. No matter how hard I study, I never do well in math courses.
11. I try to avoid situations where I would be expected to use mathematics.
12. I have no particular desire to avoid math courses.
13. It's useless for me to even consider studying subjects that require math. I'm a hopeless case.
14. I feel tense and insecure when I have to use math to solve an everyday problem.
15. I am always afraid that I will make a mistake when I have to solve a math problem.
16. I have taken as few math courses as possible.
17. I wouldn't take a job in which I had to use math frequently.
18. I hope I never have to take another math course.

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